2021 Chehalis ASRP
Oregon Spotted Frog Habitat Restoration Report

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INTRODUCTION

OREGON SPOTTED FROG NATURAL HISTORY AND HABITAT NEEDS

The Oregon Spotted Frog (OSF; *Rana pretiosa*) is one of the amphibian species most at risk in western North America, having some conservation status or watch-list designation in all political entities that encompass its geographic range (British Columbia to California). OSF were listed as state endangered in Washington in 1997 and federally threatened in 2014. The Black River Ecological Region within the Chehalis Basin has been designated by the U.S. Fish and Wildlife Service as critical habitat for OSF (USFWS 2016), aligning our work with the goals and jurisdiction of the ASRP. Furthermore, OSF is the only federally-listed species included in the Chehalis Basin Aquatic Species Restoration Plan (ASRP) and so represents a critical management target for the region.

OSF is completely aquatic throughout its entire life history and migrate between breeding, summer, and overwintering habitat throughout various waterways, a unique trait among frogs in Washington State. To meet this need, they tend to occupy palustrine wetlands connected to riverine systems (Hallock *2013*). These perennial creeks and associated intermittent tributaries provide aquatic connectivity between their breeding sites (seasonally flooded marshes with shallow sun exposed edges), summer active season habitat (perennial typically >4ha), and overwintering habitat (Hallock 2013).

Having a year-round aquatic habitat requirement increases the potential for geographic isolation from other subpopulations and increases their overall susceptibility to local extirpation. Climate change may exacerbate this isolation through the loss of aquatic connectivity among sites. With the trajectory of habitat change and interrelated conditions that threaten the species, OSF are not expected to recover without some intervention. As such, habitat management is an essential part and is outlined in the WDFW Draft Recovery Plan (Hallock 2013). Historical and current areas of floodplain marsh and pond habitats documented by NOAA using GLO mapping found that the Black River sub-basin of the Chehalis has lost or had experienced significant modifications to ~ 65% of its marsh habitats (Beechie 2018). Some of this loss is due to development, agricultural practices that drain or straighten streams, and invasion by Reed Canarygrass (RCG) which creates a monoculture stand that outcompetes native plants and alters hydrology. Additionally, beaver and large browsers, like deer and elk, along with periodic fires helped regulate ecological processes that maintained OSF habitat. Human activity has diminished browsers and fires in the region, diminishing natural processes that maintain habitat. Because of the direct loss of habitat and processes that construct and maintain habitat, OSF conservation requires interventions to create and restore habitat.

GOALS

The following focal elements of our project represent specific actions recommended in the ASRP to protect OSF.

Directly:

• Ensure continued restoration/management of OSF habitat (ponds and marshes).

Indirectly:

•Protect headwaters of already protected prairie marshes.
•Protect functioning wet prairie, floodplain, and marsh habitats, especially in the Allen Creek area.

The **Oregon Spotted Frog Habitat Restoration Project** addresses on-the-ground restoration efforts in or near OSF marsh habitat. We accomplish this by maintaining, restoring, or creating OSF habitat at multiple sites in the Black River Ecological Region and assembling important data to inform future restoration actions.

METHODS

TARGET STUDY AREA

In the Chehalis River Basin, OSF are known only in the Black River drainage which encompasses ~ 13 subpopulation areas (**Figure 1**, Lisa Hallock personal communication). Molecular data indicate a relatively high degree of population structures and varying degrees of gene flow where some populations have relatively large amounts of gene flow and others with minimal or no gene flow in the Black River drainage. These genetic data highlight the importance of each location to the overall health and diversity of other subpopulations in the Black River Drainage (**Figure 2**, Goldberg and Brinkmeyer 2015).

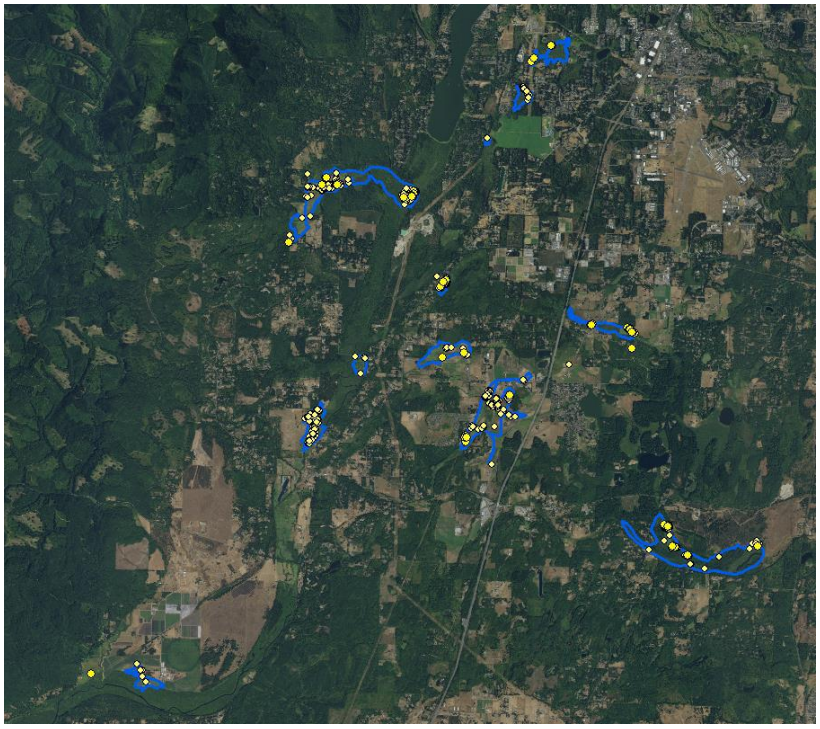

***Figure 1**: The thirteen known subpopulations in the Black River drainage*

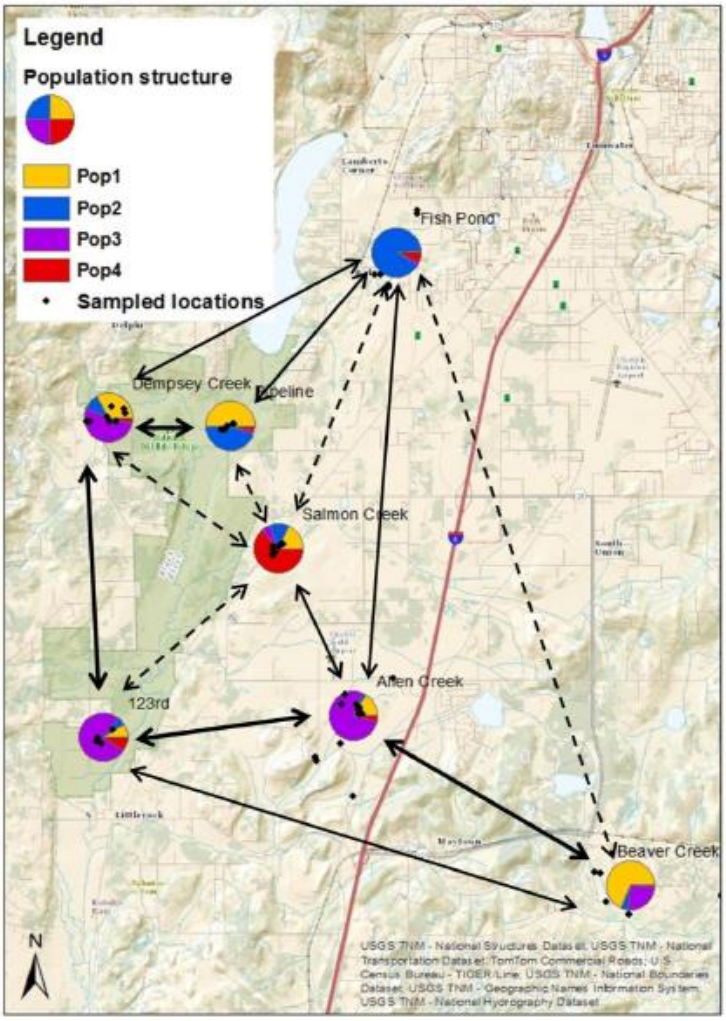

Figure 2. *Results of population structure analysis for Oregon Spotted Frogs in the Black River area of Washington. Thickness of lines between neighboring populations represent different degrees of gene flow (connectivity) and dashed lines represent minimal or no gene flow. Colors reflect results from the program Structure, with each color representing similar ancestry.*

PROJECT SELECTION PROCESS

Washington state has a coalition of partners that comprise the Washington Oregon Spotted Frog Working Group. These partners represent federal and state agencies, NGOs, timber companies, colleges, zoos, and private landowners who have a shared interest in the conservation of this species across the state. The Washington Department of Fish and Wildlife (WDFW) has several representatives in this work group and those individuals have created an internal WDFW workgroup specifically aimed at coordinating efforts for the Black River population between our partners in the Chehalis Basin. Members of the Aquatic Research Section (ARS) in the Habitat Program at WDFW are key participants and organizers in this group. The scope, site selection, and project actions that received funding for work was determined by the internal WDFW workgroup given the workgroups familiarity with OSF biology, habitat needs, and restoration priority areas that will maximize benefit to Black River OSF. All work for this listed species was conducted either by USFWS or WDFW and their subagents under a Section 6 agreement with USFWS.

The WDFW internal workgroup convened discussions in July 2019, when funds had been secured, and initiated discussion for prioritizing projects for the 19-21 biennium. We allocated funding between projects we could immediately commence working on in the fall 2019/spring 2020 (habitat enhancement activities, landowner outreach for expanded surveys to locate new populations, monitoring the status at known locations) and projects that required additional planning time and/or which might offer valuable data to guide future restoration (hydrological monitoring). For some projects we leveraged equipment/funds we had received outside of the ASRP to create a more robust project activity. Our selected projects are detailed below.

Each habitat enhancement activity will have a subsequent season of egg mass monitoring to measure potential success of the activities. Each female frog lays a single egg mass and there is an assumed 1:1 female/male ratio in the population. This means that, for every egg mass, we assume there are at least two adult breeding frogs. These counts are used as a direct measure of the *breeding* population for any given area, and this measure is used to track population status & trends. Note that egg mass counts are a useful proxy for population size for many amphibians but they do not account for abundances of juveniles and non-breeding adults.

MONITORING SURVEY DESIGN

Visual Encounter Egg Mass Surveys

The visual encounter survey (VES) is the standard technique for detecting aquatic breeding amphibian egg masses because egg masses are immobile, readily visible at the water's surface, and easily identified to species (Hayes et al. 2019). Visual encounter surveys are conducted in all wetted areas with a water depth up to 1 m (~3 ft). Boats may be required to access some areas. Ideally, egg mass surveys are conducted a minimum of three times each winter/spring (February-May). Each single day visit is separated by approximately 7-10 days. We end surveying once no new egg masses have been identified or all frog activity has disappeared.

Pit Tagging

We will be using the Biomark MiniHPT8 tags for marking all frogs. These tags are only 8mm x 1.4mm and so can be used in relatively small juvenile frogs compared to standard 12mm tags. We measure length and width on all captured OSF to assess if they meet the minimum size requirements of 25mm in length and 5 grams weight for PIT tagging. Frogs that meet the minimum length requirement but are in the 4-5 gram category are individually assessed for suitability for tagging by evaluating general health characteristics. Prior to tagging, we assess all OSF for overall health and stress. In addition, we document each OSF with a photograph, PIT tag number, location captures, and life stage, sex, and size.

Site Characteristics

At each egg mass and PIT tag survey, we assess physical site characteristics. Specifically, we record air and water temperature (to the nearest 0.1°C using a digital thermometer) and general weather conditions (e.g., sunny, overcast, cloudy, light rain, heavy rain) at the start of each survey.

In addition, we record any areas with restoration/enhancement or maintenance performed by running track lines to delineate boundaries of the perimeter on an iPad using Avenza or Collector Mapping software. In GIS we use these track lines to estimate the size of action areas. We also take Pre-Post Restoration photos to assess the effects of restoration on site conditions. 'Post' photo's will be taken

during winter to show open water and will be taken from approximately the same location as 'Pre'-photos for ease of comparisons.

19-21 Biennium Selected Project Locations, Description & Results

Work in the 19-21 biennium includes maintenance or restoration work at several sites with associated egg mass monitoring, regional egg mass surveys of known sites, landowner outreach to expand surveys, hydrological monitoring at some occupied sites, frog movement studies, invasive Bullfrog (*Rana catesbeiana*) detection/removal, and Phase 1 planning for future restoration actions for the 21-23 biennium. We are interested in both the shorter- and longer-term responses of habitats to restoration and so additional 'Post'-treatment monitoring may be necessary beyond the currently planned biennium to assess the efficacy of restoration efforts. Additionally, biotic responses may take years to manifest and so continued monitoring will be fruitful for determining whether additional restoration actions are needed.

Black River Watershed Monitoring – WDFW Regional Biologists

WDFW Regional Staff conducted expanded egg mass surveys and landowner outreach within the Black River Watershed and consolidated GIS data for all past/present survey work. Original project goals were to thoroughly survey known locations and expand surveys to document new sites in 2020. Unfortunately, covid-19 restrictions were imposed in the middle of the 2020 OSF breeding season which constrained the extent to which biologists could interact with landowners in the field and thus interfered with gaining permission to access new properties. Our intense landowner outreach effort was reduced because we were only able to reach out to homeowners by phone to request permission to access properties. In addition, the shutdown of field work imposed in late March 2020 made it impossible for us to survey beyond currently known sites in 2020. Even with those restrictions, biologists found three new sites in 2020 and collected samples from four sites in 2021 for genetic confirmation.

Figure 3. *Example of survey tracks for Oregon Spotted Frogs.*

During covid-19 restrictions WDFW was still able to hire a technician to further organize WDFW OSF survey data for the region and develop an improved system for recording survey efforts. All district staff used ArcGIS Collector to record survey tracks in both seasons. In addition, the technician collected and cleaned all submitted tracks through 2020 and worked directly with WDFW IT to streamline the process for future years. **Figure 3** illustrates a portion of the GIS database that includes all previous OSF surveys in the Black River drainage.

WDFW Black River Unit Monitoring & Restoration – WDFW Regional Biologists

Since OSF occur near the WDFW-owned Black River Unit, our workgroup recommended a season of mowing and subsequent egg mass surveys at this location. In fall 2019, we mowed an area of habitat with RCG and Himalayan Blackberry (1.5 acres) on the Black River Unit and subsequently surveyed for egg masses in 2020 (**Figure 4**). Although no OSF egg masses or activity were detected, it is unclear if OSF are absent from the Black River Unit or if mowing was done insufficiently to encourage OSF activity.

Figure 4. *Immediately post mowing restoration in Fall 2019 (A) and March 2020 during OSF breeding season surveys (B).*

Forbes and Musgrove Property Monitoring – WDFW Wildlife Program Diversity Division

The Forbes and Musgrove properties are owned by USFWS and are adjacent to each other and to Dempsey Creek (**Figure 5**). This property is under active grazing management to control RCG and annual OSF egg mass monitoring has occurred since 1995 on the Forbes property. Results of twenty-five years of egg mass monitoring indicate that the core breeding habitat for the upper Dempsey Creek watershed is on the Forbes property (**Figure 6**). Further, data from a genetic analysis indicated that the Dempsey Creek OSF population appears to be a stronghold for all the Black River subpopulations because of its high genetic diversity, no evidence of a demographic bottleneck, and high functional connectivity (exchange of migrants) with the Allen Creek and Pipeline populations (Goldberg and Brinkmeyer 2015). The long-term Dempsey Creek egg mass dataset is also important because it has captured the first day of OSF breeding for the last twenty-four years. These breeding initiation data provide an opportunity to understand breeding phenology trends over time and may provide information about how climate change is impacting OSF. This information also informs when to schedule field surveys for other sites in the Black River and how much flexibility needs to be allowed for annual variation in breeding commencement.

The Musgrove property did not have suitable breeding habitat for OSF due to RCG overgrowth. Because of this, mowing and grazing were introduced to manage RCG in 2008. OSF egg masses were first detected on this property in 2009 and management continued through the 2014-2015. After 2015, fall mowing and grazing were ended as a vegetation management tool to discourage OSF breeding because the pool where OSF breed became isolated from permanent water each year and was drying before OSF tadpoles were able to complete metamorphosis. This site functionally has become an ecological trap for OSF and we aim to discourage OSF use of it until the hydrology can be improved. Cattle, however, have breached the fencing on multiple occasions, creating areas of suitable breeding habitat. OSF continue to breed on the site in limited numbers and monitoring will continue at this site.

We found egg masses on February 8, 2020 and February 25, 2021. This most recent year marks the first time that the Forbes site was not the first site to record egg masses. Egg masses were recorded on February 10, by USFWS on the Black River Refuge's "123rd site". Unfortunately, we had heavy snowfall shortly after and most of those early masses sustained heavy mortality and several adult frogs were found deceased. The delayed breeding at Forbes and other sites in the Black River was beneficial for these sites because of this. 2021 also marks the first increase in egg mass counts at the Forbes site since 2018 when a severe decline begun and down from the historic high of 336 in 2016 (**Figure 7**).

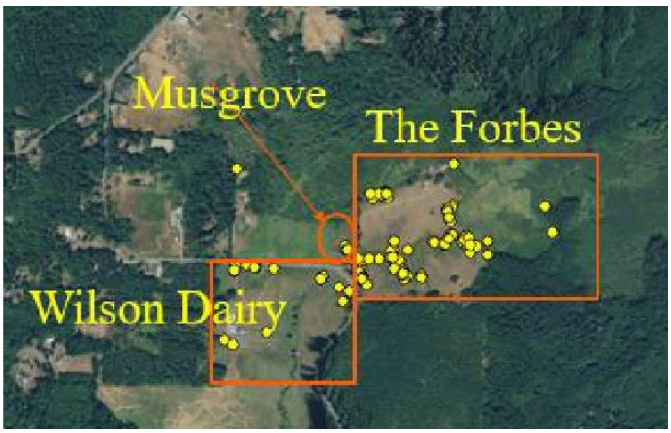

Figure 5. *Locations of The Forbes, Musgrove, and Wilson Dairy properties. Yellow dots are breeding locations through 2018.*

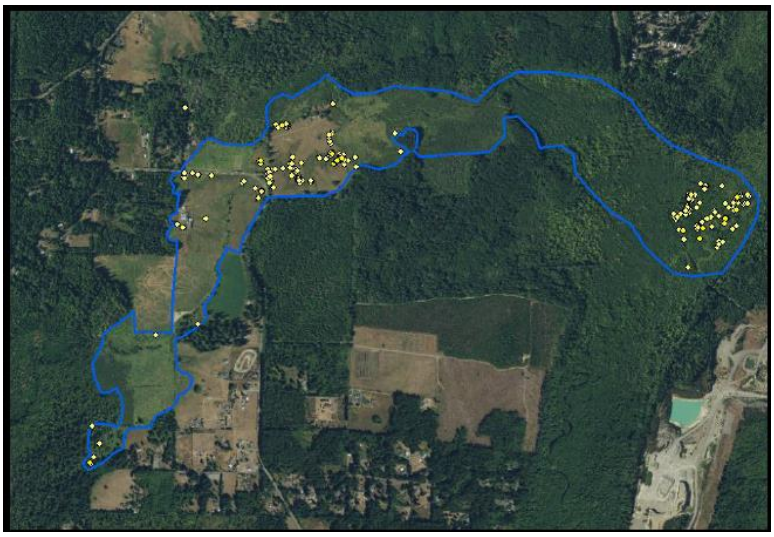

Figure 6. *Extent of OSF in the Dempsey Creek drainage (blue polygon), highlighting breeding sites in yellow.*

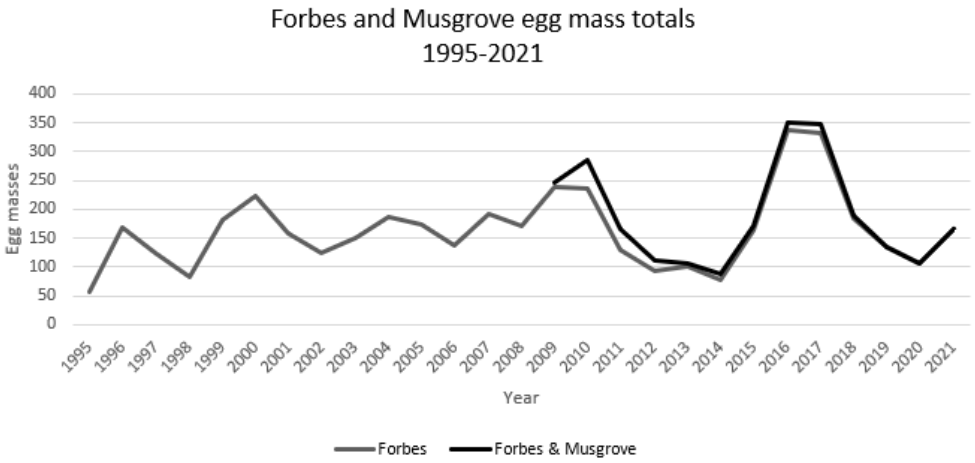

Figure 7. *Historic tread lines for egg mass totals at the Forbes and Musgrove Sites.*

Wilson Dairy Hydrology – USFWS Biologists

The Wilson Dairy site is one of several sites within the Dempsey Creek watershed that is adjacent to The Forbes and Musgrove sites (**Figure 5**). The site was determined to be an OSF breeding site in 2004 and has been continuously surveyed since 2009. In 2012, the USFWS took over ownership of the property. Egg mass counts have ranged from six to 100 each year. Primary concerns at the Wilson Dairy site include water retention, a lack of hydrological connectivity to Dempsey Creek, invasive RCG, and predatory Bullfrogs.

In November 2017, USFWS started measuring the water level at Dempsey Creek to determine the extent and duration of surface water for potential breeding and rearing habitat. In the winter of 2019, three piezometers (groundwater monitoring wells) and a barologger were installed at USFWS Wilson Dairy Site (**Figure 8**, Piezo 1-3). These data will inform managers and hydrologists on the hydrological connection between groundwater and creek surfacewater where most OSF breed along Dempsey Creek. Water monitoring data, as well as other site data (e.g., topography, soils) are necessary to identify focal areas at the refuge for wetland restoration activities to benefit OSF throughout their life history. We anticipate that restoration efforts could occur as early as 2023.

In late 2020, the Refuge acquired the 14 acre Coker Parcel to the north of the Wilson Dairy Site (**Figure 8**). Dempsey Creek, which is used by OSF, runs through the parcel. In anticipation of the land purchase, Refuge staff installed two additional loggers on the parcel (**Figure 8**; Coker East and West) to monitor the hydrological connection between Dempsey Creek and the known oviposition site at Wilson Dairy. This parcel is of high importance due to our hypothesis that this land provides the hydrological connection between OSF oviposition at the Wilson Dairy site to Dempsey Creek where the frogs overwinter. The two parcels are connected by five (5-6 foot) culverts beneath Delphi Rd (loggers were installed at the culverts). In August 2020 refuge staff observed several juvenile OSF using the culverts in August 2020. In total, the Refuge now monitors water levels at nine locations (**Table 1 & Figure 8**). Previously proposed groundwater piezometer installation for the Musgrove and the Forbes Sites were initially scheduled for the future; the earlier installation of these piezometers means that new installation can now be placed at the Coker parcel and Delphi road culverts.

In the spring of 2020, we identified issues with the three groundwater piezometer loggers at Wilson Dairy. As the water levels dropped in the spring, sediment infiltrated the groundwater monitoring wells, causing the loggers to rest upon ~3-8 inches of sediment. With concerns of data quality, we corrected the issue in the fall of 2020. For this correction, the loggers were raised out of the mud with the goal of minimally raising the loggers so they could continue monitoring water levels during the late summer, when groundwater levels are expected to be the lowest. After reviewing the data from early 2021, our adjustment appears to be allowing the loggers to provide more accurate data that closely aligns with water levels observed in Dempsey Creek. An additional season (2021) of data is needed to understand groundwater conditions at the Wilson Dairy Site before any restoration decisions can be made.

With several site visits in summer 2020, the Refuge biologist monitored decreasing surface water levels across the site. Because of limited precipitation, water levels receded to the point where only a few inches of water remained in culverts. These culverts acted as refugia for some juvenile OSF and red-legged frogs (*Rana aurora*). With the cooperation of the USFWS Ecological Services, ~40 OSF were moved to Dempsey Creek before three of the five culverts went dry. Two tadpoles and one subadult Bullfrog were captured and removed from the site during the OSF relocation.

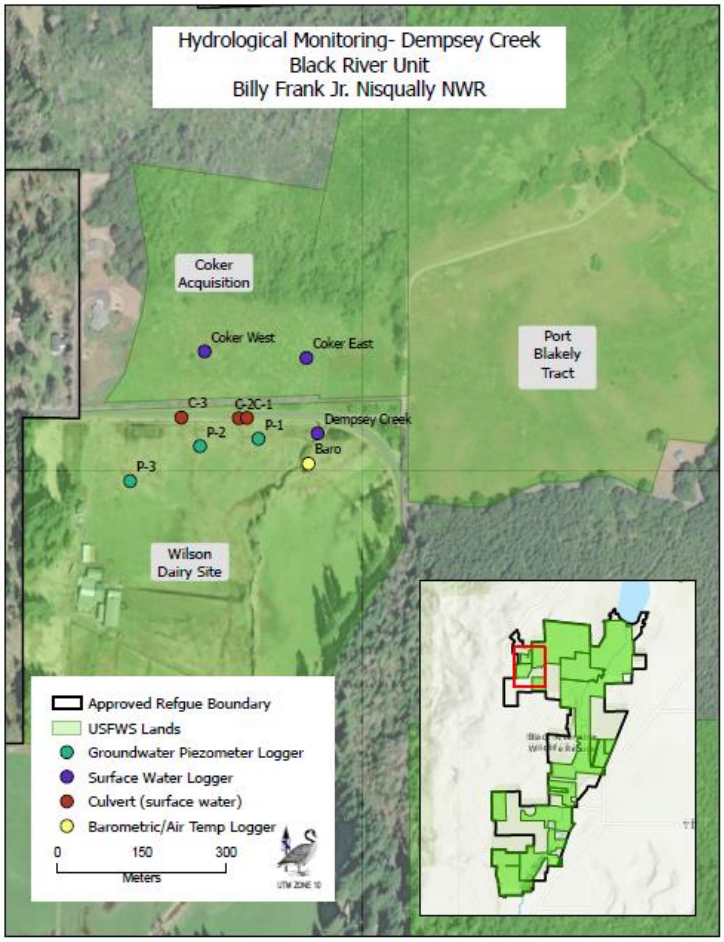

Figure 8. *Locations of groundwater wells at Wilson Dairy Property (Piezo 1 – 3), Dempsey Creek Gauge and Barometric Logger and the 2020 installation of loggers on the Coker Parcel (East and West) and Delphi Road Culverts (C1, C2 & C3)). Inset photo is showing location of Wilson Dairy Site and the current refuge properties in green and proposed boundary in black.*

Data Logger Name	Type	Established
Dempsey Creek- Water Level	HOBO- Creek Surface Level	November 2017
Dempsey Creek- Baro Logger	HOBO- Barometric and Air Temp Logger	November 2017
Wilson Dairy Piezometers- 1,2, & 3	HOBO- Groundwater Loggers	November 2019 (modified Oct. 2020)
Delphi Road Culverts- 1,2, & 3	Surface Water Levels	November 2019
Coker Parcel (East & West)	Surface Water Levels	October 2020

Table 1. *Locations of water level monitoring stations on the USFWS Black River Refuge*

USFWS Black River Unit Invasive Bullfrog Monitoring & Eradication – USFWS Biologists

The Black River Unit of the Nisqually National Wildlife Refuge is owned by USFWS and encompasses several areas adjacent to the Black River that are important for OSF (**Figure 8 inset**). This unit has similar habitat issues like those seen at other sites in the Black River. Most of these breeding areas on the refuge have some degree of habitat enhancement activities being performed by USFWS to benefit OSF

About 9 kilometers (straight-line distance) south of Dempsey creek, more than 50 Bullfrog tadpoles and juveniles were observed in the Black River within 500m of the OSF breeding site known as 123rd in September 2019. Several individual Bullfrogs have also been captured in Dempsey Creek near Wilson Dairy and at the Forbes site but no breeding Bullfrog population is believed to have been established there yet. Biologists have also identified a Bullfrog population immediately upstream from refuge property at Lake Louise and in the connected wetlands of the Capitol Land Trust Darlin Creek Property. Bullfrogs have also been found downstream ~7 km away at the 110th Ave SW Bridge crossing the Black River. Proposed work for this subproject involved early detection and removal of Bullfrogs before they can become established at any breeding sites within the refuge.

- *Bullfrog monitoring*

Adult Bullfrogs have a distinctive call and this project uses acoustic monitoring equipment and software for early detection of invasive Bullfrogs on the Black River Unit. This method provides staff the ability for a rapid response with the intent of Bullfrog eradication before a breeding population establishes. USFWS installed 28 acoustic monitors (AudioMoths) on the Black River Unit in 2020 and 2021 (**Figure 9 & 10**). AudioMoths were deployed from June through August 2020 within the Refuge and recorded calls for 5-minute intervals every 30 minutes, from 7:00 pm – 2:00 am (i.e., the nightly timeframe of concentrated Bullfrog breeding). This equated to 14 surveys/night for 70-90 nights during the summer.

Figure 9. *Audiomoth equipment and field installation.*

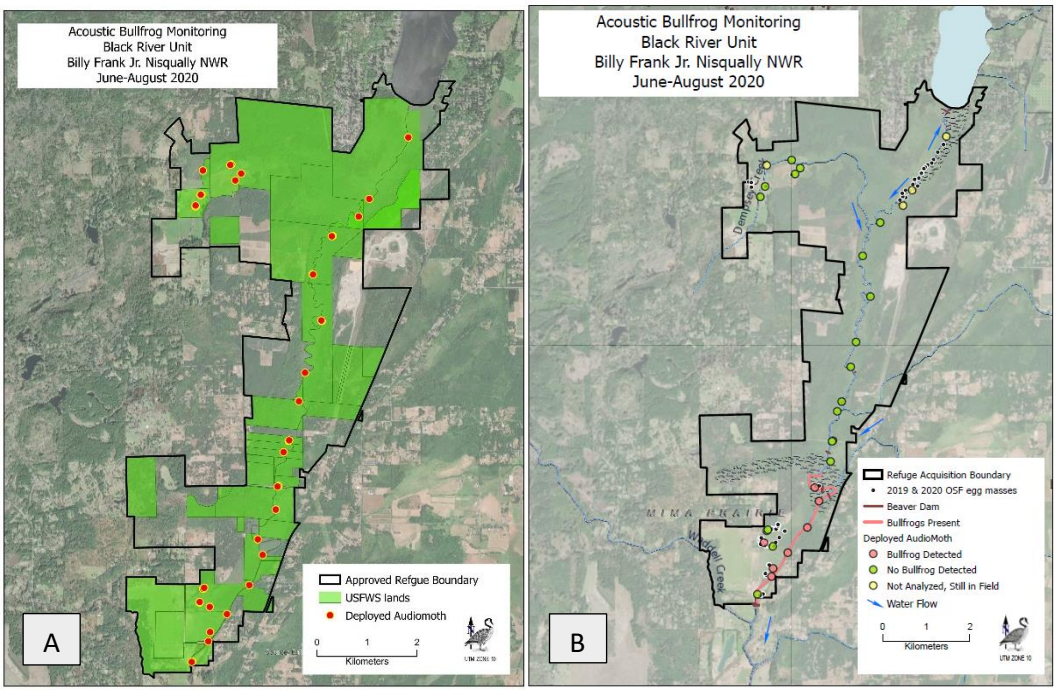

Figure 10. *Locations of Audiomoth Acoustic Monitoring Devices (A) and Bullfrog audio detections (B)*

Using Wildlife Acoustic's Kaleidoscope Pro Software, cluster analysis searched through 25,000 5-minute surveys (~1 terabyte of data) to identify Bullfrog calls. Bullfrog calls were found to have a broad frequency range (90-4000kHz) and a peak energy of 1000-1400 kHz. Each call is ~0.5 secs and there are typically clusters of 1-5 calls (**Figure 11**).

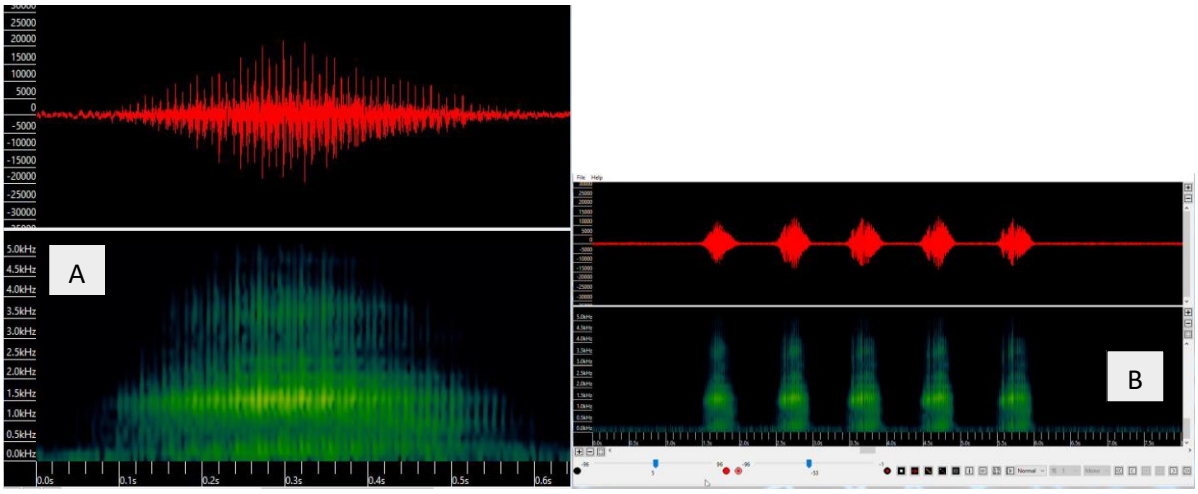

Figure 11*. Bullfrog calls from Audiomoth devices.* ***A*** *is zoomed in on a single call, and* ***B*** *is a 5 second cluster of calls. Red is a Oscillogram (amplitude or loudness) and Green is a Spectrogram (frequency).*

Bullfrogs were detected at 7 of the 24 analyzed locations (**Figure 10**). Due to the pandemic, four sites were not analyzed for Bullfrogs as the devices had not been retrieved from the field before analysis. The positive detections from the acoustic loggers matched observations of Bullfrogs during nighttime surveys in 2020.

Audio data of Bullfrog presence data have directly guided efforts for Bullfrog eradication which began in August 2020. In 2020, 74 Bullfrogs were removed over seven nights of work. In July 2021, two technicians will continue removing Bullfrogs in the areas identified by the deployed acoustic devices. As acoustic monitoring devices were redeployed in April/May 2021, they continue to monitor for invasive Bullfrogs and will direct future Bullfrog removals. Given invasive Bullfrogs can harm OSF populations by directly consuming OSF, these removals are an important habitat restoration action.

- *Bullfrog capture and removal.*

The Refuge also trapped and removed Bullfrogs along the Black River around the 123rd site during the summer of 2020. There are multiple Bullfrog trapping techniques and efficacy varies depending on Bullfrog life stage (tadpoles vs. adults), site conditions (emergent/seasonally flooded wetland vs. river), and seasonality. A combination of trap types (including hand capture) have been used to control this Bullfrog population.

In 2020, the Refuge experimented with trapping Bullfrogs at Billy Frank Jr. Nisqually headquarters, where a robust Bullfrog population exists. After trying multiple trapping styles over multiple weeks, no Bullfrogs were caught. Currently, only hand captures and gigging are effective and so we do not anticipate future trapping efforts. We also gigged Bullfrogs at the headquarter's ponds to improve our gigging technique.

Both the acoustic monitoring and the success in removing Bullfrogs has encouraged the Refuge to increase removal efforts for the 2021 season. The Refuge was awarded a Small Invasive Species Grant for the fiscal year 2021, allowing the Refuge to fund two technicians for 10 weeks (3 days/week) starting July 7th, 2021. Based on data from last year, we are anticipating the need to continue Bullfrog removal efforts in 2022 and 2023. As we collect more data (Bullfrog removal and acoustic recording data), we will reassess the crew size and duration needed for Bullfrog eradication. We also anticipate the use of air rifles to increase removal efficiency. Audiomoth recorders will continue to be deployed in the coming years and we will determine a successful reduction in Bullfrogs counts when those audio detections and captures by technicians diminish.

West Rocky Prairie Monitoring, Restoration & Hydrology – WDFW/ARS & Partners

The West Rocky Prairie Unit (WRP) is owned by WDFW and represents the furthest east subpopulation. This unit was the first location where OSF were discovered in the Black River basin in the early 1990's and, to date, is the only known population along Beaver Creek. In addition to Beaver Creek, one of the breeding areas is in the headwaters of Allen Creek. The main habitat challenges at WRP are RCG invasion, woody vegetation succession (willows, hardhack, etc.), and maintenance of hydrological connections among waterbodies and hydroperiod permanence.

There are four main breeding areas within the unit and gene flow occurs between each area and with other Black River subpopulations in the basin (**Figure 2 & 12**). This site has been monitored inconsistently for egg masses since 1999, with consistent yearly monitoring of the West and East Areas since 2009 when restoration activities began, resulting in 13 years of data for those two areas. This yearly egg mass dataset is the second longest for the Black River, making it invaluable for status and trend assessments. If we examine the timeline for the West area, we observed a substantial increase in overall egg mass counts from 2013-2015 relative to prior years (**Figure 13**). Initially we believed this may have been a lag effect of habitat enhancement efforts that began in the fall of 2009. However, in 2016 we observed a substantial drop in egg mass counts for that area. This trend has continued through 2019 and then in both 2020 and

2021 we have observed only small increases in egg mass counts for the West breeding area which is the strong hold for WRP OSFs (**Figure 13**). In 2021, we observed a 4-fold increase in egg mass counts for the Eastside breeding area over 2020 counts (13 vs 3). Even with increased habitat enhancement and restoration efforts across the entire unit, egg mass counts are reduced from historic counts in all areas, although we are observing some slow increases in breeding which highlights the importance of continued long-term monitoring.

This subproject addresses three objectives at the WRP OSF site: 1) limit invasive RCG and woody vegetation to enhance OSF breeding habitat; 2) hydrological monitoring, and 3) OSF movement studies to prioritize future restoration efforts. All efforts are anticipated to contribute to either an increase in the OSF oviposition habitat footprint, an increase in OSF population size, and informing and prioritizing future restoration actions.

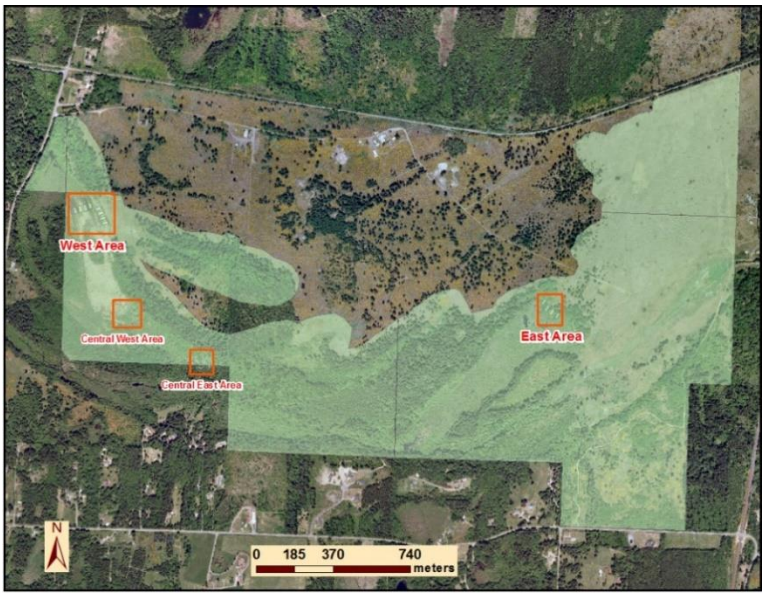

FIGURE 12. West Rocky Prairie Unit. The orange boxes indicate the four known breeding areas.

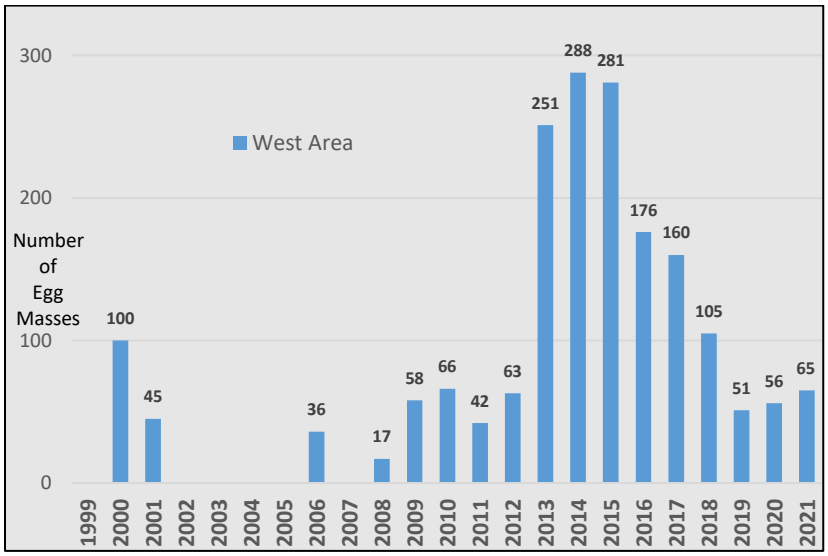

***Figure 13.** Egg mass counts for the West Area at WRP.*

- *Habitat enhancement/maintenance of breeding/rearing locations and egg mass monitoring* - WDFW/ARS

Habitat enhancement mowing activities of RCG began in 2009 at the West and East areas and has continued annually. In 2016, mowing of RCG and woody vegetation removal started in the Central areas, and woody vegetation removal began in the East areas in 2018. Until a permanent solution for RCG removal is approved, a yearly mowing regime (late summer/early fall) is required for maintenance of these enhanced locations. Funding for restoration activities in 2019 was leveraged from another grant. However, 2020 RCG and willow regrowth maintenance in all four breeding areas (2.5 acres) was funded by the ASRP. The breakdown by activity and area can be seen in **Table 2**, and an example of restoration maintenance in the Central East Area is in **Figure 14**.

In January 2021, Jane Atha (WDFW) flew a drone over the West and Central West breeding areas. This provided a winter aerial view showing how restoration efforts (mowing/willow abatement) benefit OSF breeding habitat not only in structure but also by maintaining hydrological connectivity (**Figures 15 & 16**).

Area	Acres Restored in 2020	RCG Total	Woody Veg Total
East	1.14	0.24	0.90
Central East	0.41	0.41	0.00
Central West	0.41	0.33	0.10
West	0.52	0.52	0.00

Table 2. *Breakdown of restoration activities by area for WRP.*

Figure 1*. Example of photo point changes pre-restoration (left) to post-restoration (right) enhancing oviposition habitat in the Central East Area of WRP. Red arrow highlights large alder that was removed to increase solar radiation.*

Figure 15. *Drone aerial photos of WRP West Breeding Area. Mowed breeding sites are the rectangles surrounded by dense RCG.*

Figure 16. *Drone aerial photo of WRP Central West Breeding Area. Mowed breeding areas are filled with water. In the center of the photo there is a watered channel connecting the north and south areas together; this area is where willow abatement occurred. Prior to this abatement, there was no break in the wall of trees which reduced hydrological connectivity for the frogs between the areas.*

- *Hydrology monitoring studies* - Northwest Land & Water (NLW)

Hydrological monitoring began in 2013 by NLW at 14 ground and surface water stations across WRP. We continued monitoring of those stations this biennium (**Figure 17**). These data, along with elevation, precipitation, flow, and soil data, will be used to analyze potential hydrological changes that may be occurring in the unit. This information will be used for future hydrological modeling to determine if hydrological restoration is feasible for improving aquatic conditions immediately and under future climate change scenarios. This modeling will also help spatially target where restoration should occur in WRP. Possible future work could involve installing beaver dam analogs or creating additional small ponds to maintain summer water in the West Area.

This work is partially funded from Black Hills Audubon who has funded the hydrology work since 2013 as part of mitigation for the Maytown Gravel Mining operation on an adjacent property to the north. The balance was funded through this project.

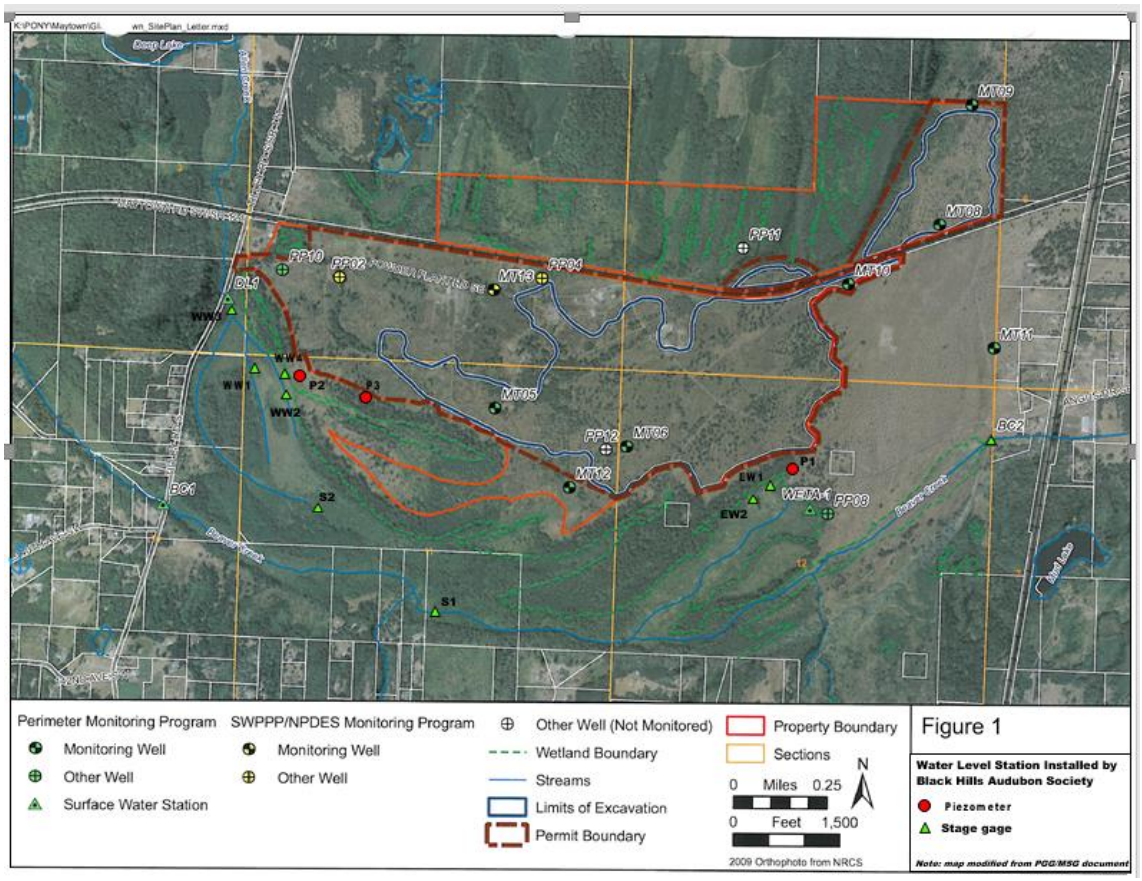

Figure 17. *Location of the 13 hydrological monitoring stations at West Rocky Prairie*

During this biennium, quarterly water level monitoring of all stations was done which includes surface water level stage gauges and groundwater level piezometers. An example of the 9 years of surface water level data available from station WW2 is in **Figure 18,** similar data sets are available for all stations. Additionally, two more stations were installed to monitor surface water flow on the westside where Beaver and Allen Creeks flow under Tilley Road. These new stations are also being monitored quarterly.

In the fall of 2019, WDFW CAMP division conducted Total Station Elevation Surveys in preparation of future restoration work at all 14 stations and again in 2020 at the two newly installed creek stations. This base station data, in combination with water level data, offer a more thorough picture of hydrological changes occurring at WRP.

Planned work for summer 2021 includes identifying the interface between the wetland soil, sand, and gravel that comprise the shallow aquifer. Locations where this depth is measured will also have follow up total station surveys. At the end of December 2021 all the data needed for future hydrology models will be collected.

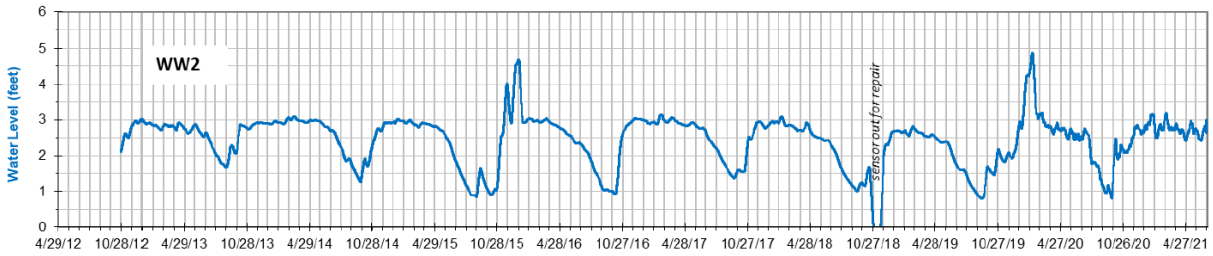

Figure 18. *9 years of water level monitoring at station WW2.*

- *OSF movement studies to identify high priority habitats* – WDFW/ARS & West Fork Environmental

Understanding hydrological usage across seasons is a necessary element for successfully restoring OSF habitat. Hydrological changes have been incidentally observed over the last few years at most OSF oviposition sites in the Black River. Some observed changes include reductions in the amount of water available at oviposition sites and shorter hydroperiods. These changes can result in oviposition sites drying faster or becoming disconnected from permanent water at rates faster than at which tadpoles can complete metamorphosis. These changes can cause OSF embryos and tadpoles to become stranded and die. Additionally, some sites are observing decreases in available summer water habitat. Reduced aquatic habitat can result in lower dissolved oxygen, loss in prey base due to overcrowding, predator traps, and heat stress. The hydrological monitoring that NLW has done since 2013 confirms that WRP is experiencing decreases in both available summer water habitat and faster drying of oviposition sites.

We want to augment the current habitat enhancements at WRP with restoration actions aimed at improving aquatic conditions throughout the year. To better facilitate this activity, it is paramount that we understand how OSF use different habitats across seasons. To meet this need, we installed PIT tag arrays and have been tagging frogs >25mm in length to monitor movements in the West Area, the region of WRP which has the largest population and which are the headwaters to Allen Creek (**Figure 19**). These movement data will be joined with the NLW's hydrological model to optimize the best locations for restoration actions aimed at improving year-round hydrological conditions.

To date, we have tagged 117 frogs since 2015, most of which were tagged in 2020 after we installed the PIT tag arrays. Most effort was spent capturing and tagging frogs in the West Area where the arrays are located (n=94), however some effort was spent tagging frogs in the other areas (n=26) as we have evidence of occasional migration between breeding areas (genetic exchange). The breakdown by area and life stage can be seen in **Table 3**. To maximize our captures starting in 2020, we concentrated efforts during two timeframes: 1) oviposition when the frogs were congregating at breeding sites and 2) during summer when water levels were contracting and concentrating frogs into their summer habitats. Even with these focused efforts, we infer that we are capturing only a small subset of female frogs in the population because our capture numbers are far lower than egg mass counts. For example, in 2021 we had 65 egg masses in the West area, but only captured 2 female frogs. Unlike male frogs, females tend to be more reclusive and, in general, leave breeding areas shortly after oviposition. Because of this, females are typically much harder to capture than males.

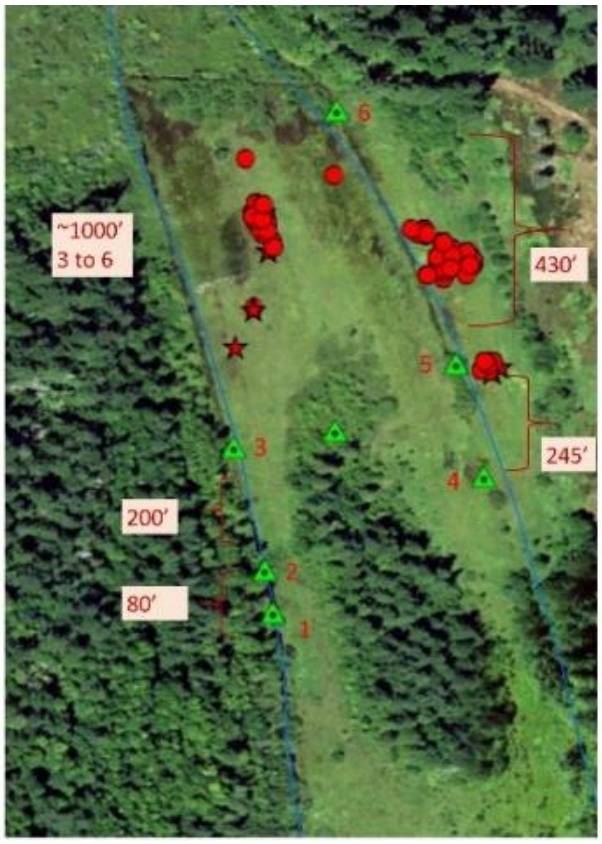

***FIGURE 19**. PIT tag arrays in watered ditches around the West Area of WRP (green triangles along blue streamlines). The solar control panel is the green triangle in center of photo. Red dots and stars are oviposition areas documented since 1999. Distances in feet between each array are labeled.*

	All Years	2015	2019	2020	2021	West	East	Central West
Total to Date	117	8	9	68	32	91	25	1
Male	66	5	6	38	17	56	10	0
Female	19	2	3	12	2	16	2	1
Juvenile	32	1	0	18	13	19	13	0

***TABLE 3**. Counts of PIT-tagged OSF at West Rocky Prairie by stage/sex and area of capture.*

We began tagging frogs at oviposition sites in 2020 and 2021 represents the first season for which we collected recapture data at oviposition sites. During oviposition in 2021 we captured 50 OSF, of which 32 were newly captured without tags and 18 had been previously been tagged. Of those 18 recaptures, 15 had returned to the same general breeding location they were tagged at in 2020. Of the other frogs, two returned to a new unrelated oviposition site and one was originally caught away from an oviposition site. Although OSF are often characterized by a high degree of site fidelity, there are few empirical data confirming site fidelity across years. Our data offer strong support that OSF show a high degree of site

fidelity. In addition, of the 50 OSF, we had 27 frogs recaptured multiple times (all males) over the course of a few weeks, indicating a continued presence at the breeding sites beyond the end of oviposition, particularly for males.

Since our PIT-tag arrays have been active (Oct 2019), we have detected 75 of 117 tagged frogs (64%) going through the arrays. This does not include the 25 frogs tagged on the East side; if we exclude those frogs from the total because of the large distance between these sites (2,150 m away), we have detected 82% of the local frogs passing through our arrays. These data are providing a wealth of information on where and when individual frogs are moving through the wetland seasonally and where they are congregating. These data will further provide valuable information on where we should focus our restoration efforts.

The only frog tagged in the Central West Area was a female which was captured at a breeding site in 2020 where she had just laid eggs. On February 28, 2021 she was picked up by the arrays directly adjacent to a breeding site in the West Area. She stayed for a short period before quickly passed through the last set of arrays heading back to the Central West Area on March 3. This was the only tagged frog that was detected moving to an entirely new area.

Shortly after our arrays went active late in 2019, we detected two adult male OSF that were tagged in 2015. This observation is important as these frogs were adults upon first capture in 2015 and so re-detecting them in 2019 placed their ages to at least six years old. One of these frogs has not been observed by the arrays since April of 2020 while the other is still actively being detected at our arrays which places his current age to at least eight years old. There are limited data on OSF age and, to our knowledge, the longest record was for a single PIT-tagged individual that was at least nine years old (K. McAllister, pers. comm.; Hallock 2013). The longevity for most OSF is likely shorter (Licht 1975, McAllister and Leonard 1997).

Salmon Creek Monitoring, Restoration & Hydrology - WDFW Regional Biologists & Partners

Salmon Creek is a privately-owned property where WDFW does restoration efforts to enhance OSF habitat. This OSF breeding site was discovered in 2010 and is one of only two known populations in the Salmon Creek drainage. Since its discovery, it has been the focus of restoration activities ranging from mowing maintenance of RCG and experimental vegetation manipulation.

This subproject addresses two objectives at the Salmon Creek site: 1) limit invasive RCG to enhance OSF breeding habitat; and 2) to reduce the invasive Bullfrog via habitat manipulation to enhance OSF survival. Both efforts are anticipated to contribute to either an increase in the OSF oviposition habitat footprint and/or an increase in OSF.

- *Habitat enhancement/maintenance of breeding/rearing locations and egg mass monitoring* - WDFW

Previous mowing at this site was done experimentally and included mowed plots separated by un-mowed areas followed by OSF breeding monitoring the following year. This experiment yielded mixed results compared to other locations where mowed areas were almost exclusively used for breeding. Specifically, OSF breeding seemed concentrated in mowed areas in one year but was absent in mowed areas and present in unmowed areas the following year A leading hypothesis for this result is that variable yearly hydrology caused mowed areas to be either too shallow or too deep for oviposition. Unfortunately, limited resources made it difficult to mow larger swaths of RCG. However, this experiment also highlights

how mowing RCG may not be a sufficient restoration action on its own to maintain quality OSF habitat and that other aspects of a site's hydrology likely need to be addressed. In the 19-21 biennium, we expanded previous mowing enhancement efforts to the full length of the stream corridor on both sides (0.92 acres) and in Year 2 we expanded this out even further (1.93 acres total) (**Figure 20**). Habitat response monitoring occurred each year and included comparing OSF oviposition patterns, water depth, and temperatures between adjoined mowed and un-mowed areas (**Figure 20**).

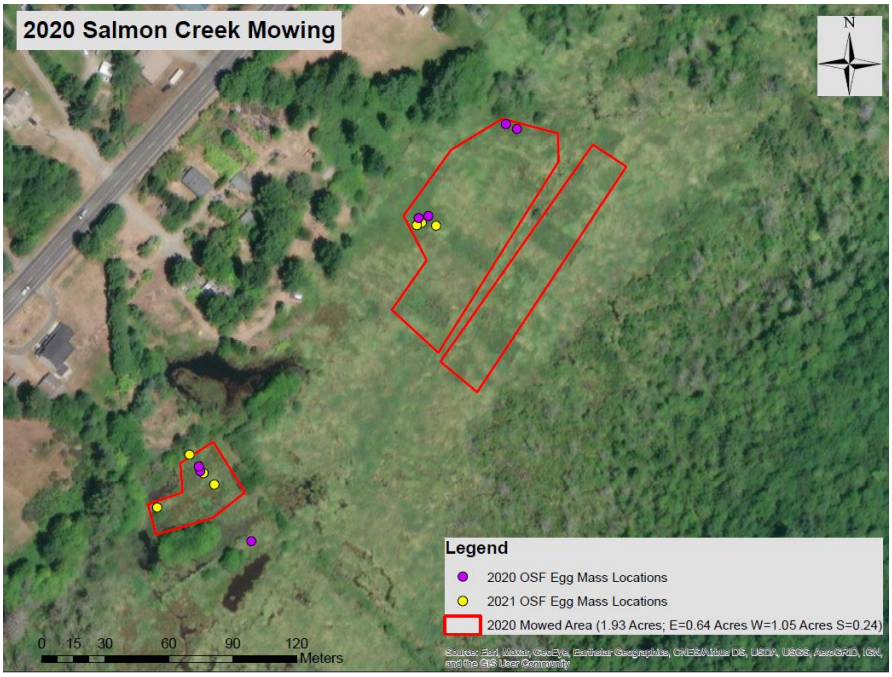

***Figure 20**. Salmon Creek Site mowing enhancement for 2020 and egg mass locations for 2020 & 2021.*

- *Hydrology monitoring studies* – WDFW & Jim Terry - Volunteer

The large pond on the property supports Bullfrogs capable of consuming OSF. At least two visits per week are required to remove Bullfrog eggs that are deposited between June and September because Bullfrog egg masses hatch in several days. In 2016, over 50 visits were documented to remove Bullfrog eggs and adults. This level of effort is not sustainable, and a longer-term solution is sought to control or discourage the Bullfrogs at this site.

Bullfrogs thrive in warmer surface waters temperatures and where tall emergent and shoreline cover exists for hiding. Pond modifications may reduce the habitat suitability for Bullfrogs. Lowering the surface temperature may reduce the habitat suitability for Bullfrogs and improve the pond for use by native amphibians and fish.

Pond aeration could result in lowering surface temperatures below 24 C, which is the ideal temp where most Bullfrog breeding occurs. If water surface temperatures can be maintained continuously below 24 C, the habitat suitability for Bullfrogs may decline (Graves and Anderson 1987). Additionally, by exposing water low in dissolved oxygen (D.O.) to the water-air interface, average D.O. concentrations should increase, providing more favorable conditions for salmonids and other cool water species.

This project funded pre-project monitoring of habitat conditions and the installation of a pond aerator and air diffusers in summer 2021. Habitat response monitoring for changes in Bullfrog habitat will consist of documenting water temperature, dissolved oxygen, turbidity, pH, alkalinity, dissolved carbon dioxide, and evaluating the distribution and numbers of breeding adults Bullfrogs and/or their egg masses. Adult Bullfrog and egg masses will be removed when detected per WDFW permits. Bullfrog breeding activity will be compared with previous years breeding activity.

Nine Tidbit temperature loggers were deployed on March 10, 2020. On July 16, 2020, four (4) miniDO2T dissolved oxygen loggers were deployed (**Figure 21**). This latter deployment was delayed due to covid-19.

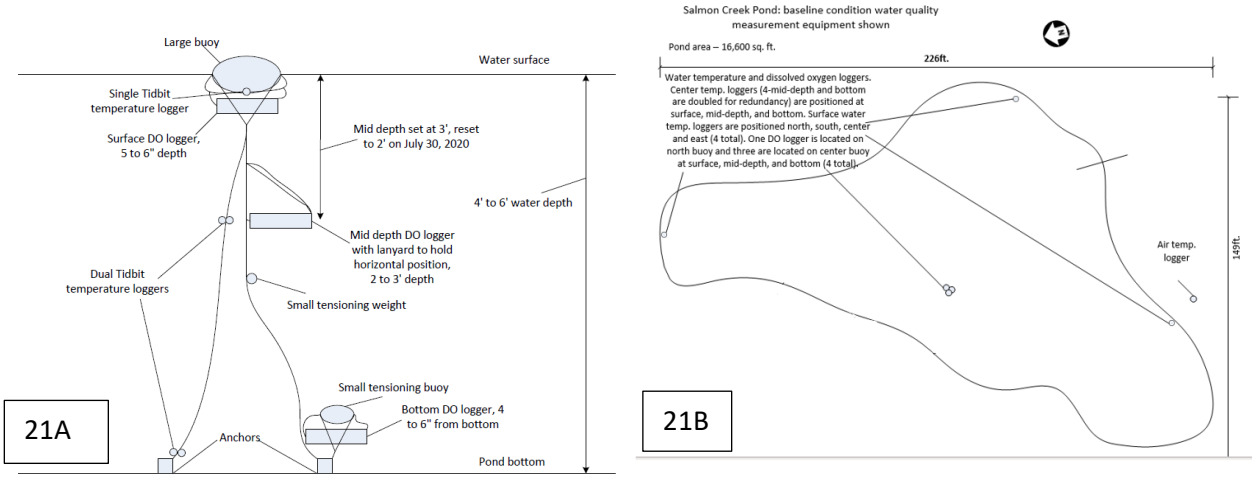

Figure 21*. Logger and sensor deployment arrangements (A) & locations of deployment in the pond (B).*

As an example of data collected to date, we present an abridged analysis from a two-week period in summer 2020 when the highest temperatures of the year were recorded. Surface temperatures in this time frame were warm and variable (mean = 22.1˚C, max temperature = 29.3˚C , min temperature = 17.3˚C) (**Figure 22**) and temperatures in the middle of the water column were similarly warm but substantially less variable (mean = 16.4˚C, max = 19.1˚C, min = 14.6˚C) (**Figure 23**). However, bottom water temperatures were cold and largely static (mean = 13.4˚C, min = 12.4˚C) with temperatures not surpassing 14.6˚C (**Figure 24**). Our experimental aeration is predicted to cause colder bottom water to mix with warmer surface water, cooling areas of the pond that Bullfrogs use as habitat. Daily fluctuations of dissolved oxygen and the difference between surface, middle and bottom levels of DO can also be seen in Figures 22 - 24. Additionally, anoxic conditions (zero D.O = ≤0.1 mg/L.) exist in most of the water column with the bottom sediment fully anaerobic at 0.075 mg/L (Figure 24). These graphs highlight the very different environments caused by lack of water movement in this pond.

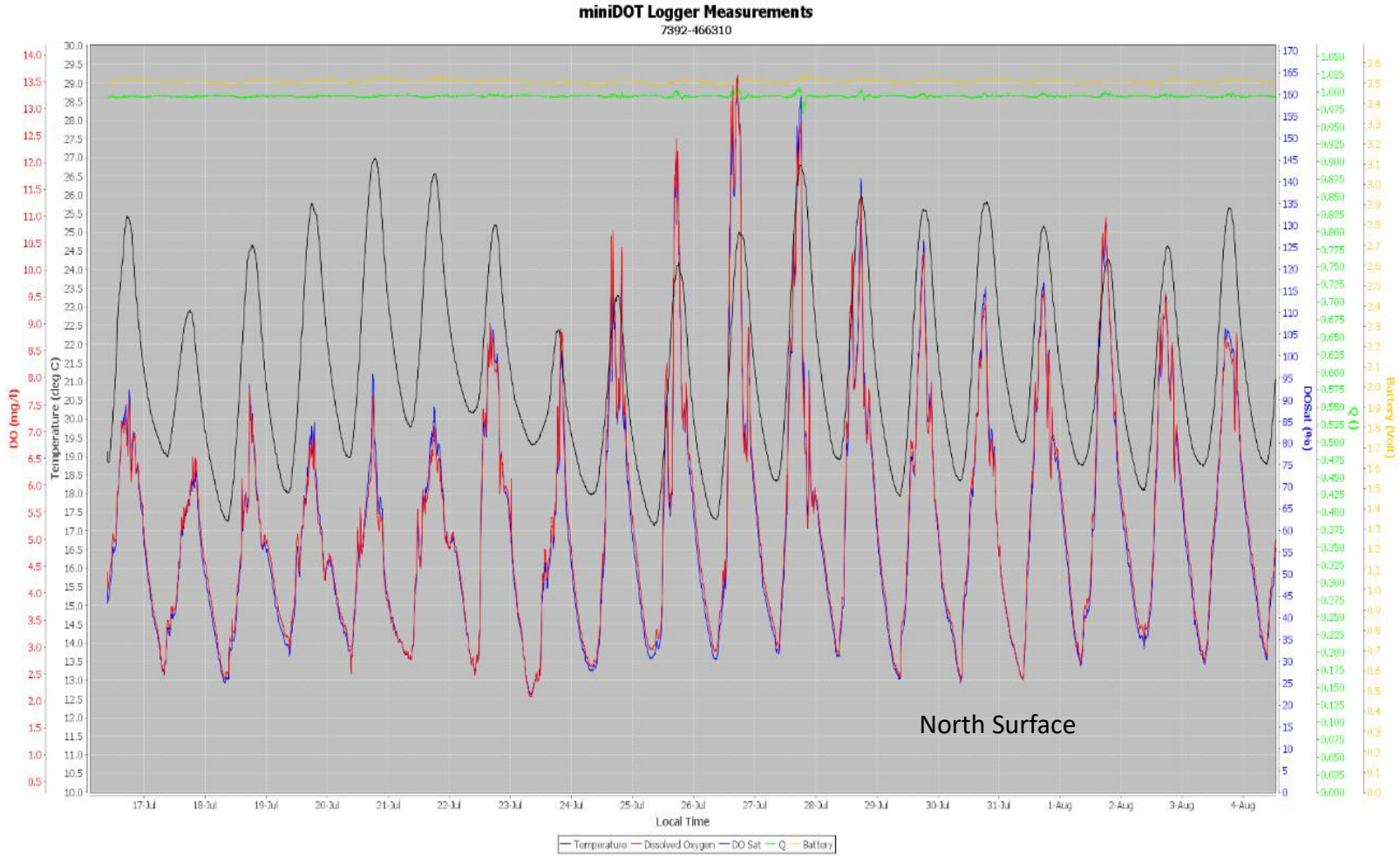

***Figure 22**. Dissolved Oxygen and Temperatures for the North Surface location at Salmon Creek.*

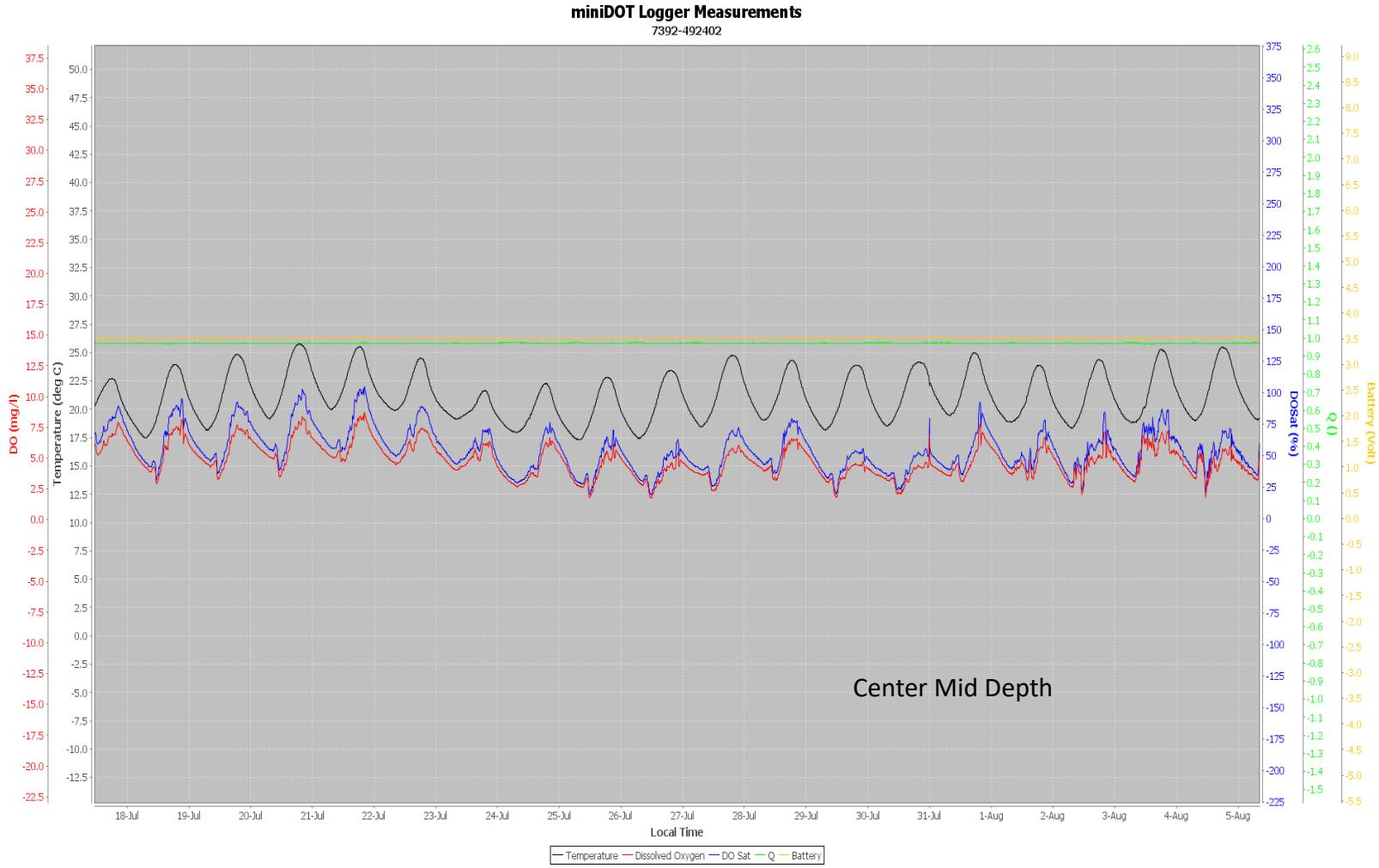

***Figure 23**. Dissolved Oxygen and Temperatures for the Center Mid Depth location at Salmon Creek*

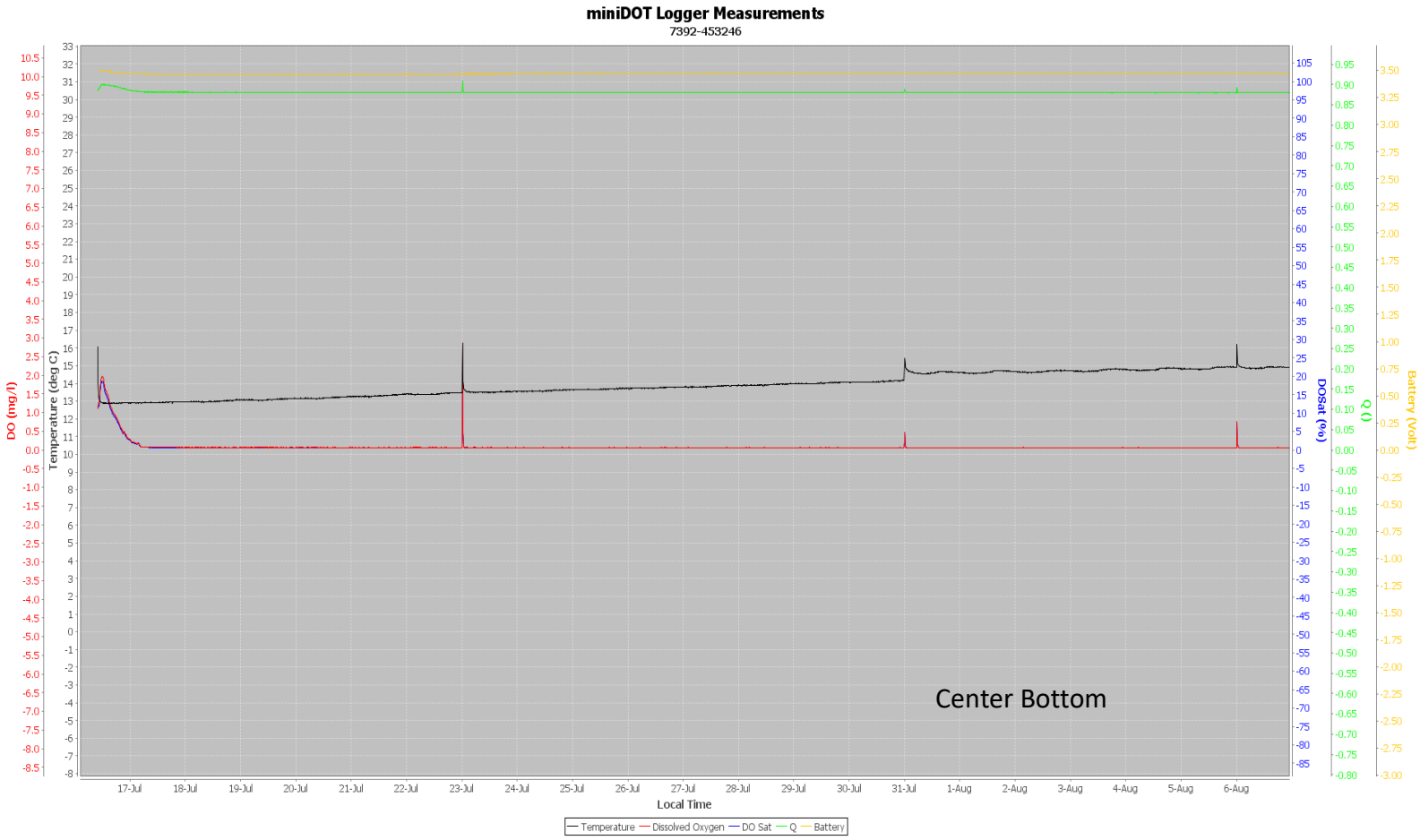

***Figure 24**. Dissolved Oxygen and Temperatures for the Center Bottom location at Salmon Creek.*

Additional water sampling protocols: The following water quality data are currently being collected bi-weekly between 11:00 PM and 1:00 AM to minimize the effect of photosynthesis: pH, temperature, total alkalinity, dissolved carbon dioxide (CO2), water depth, and turbidity. We calculated CO2 levels from pH and alkalinity measurements and have observed a CO2 gradient from bottom to surface, with over 100 ppm on the bottom compared to 20 ppm at the surface. In addition, we documented high diurnal fluctuations in shallow water near shore (about 0.5 m depth) at the north end of the pond compared to the center of the pond. The remaining data will be reported in subsequent reports.

Analysis of results: The most important data to be analyzed will be the temperature gradient recorded by the Tidbit loggers and the Dissolved Oxygen data from the D.O. loggers. Our analysis will inform whether there is sufficient mass of cooler, deeper water to reliably reduce surface water temperature below 20 degrees Celsius. This will be most difficult to accomplish when water levels are lowest in the summer.

Rogers Property Monitoring & Restoration - WDFW Regional Biologists & Landowners

WDFW has an agreement with the owners of the Rogers Property to advise management of this site for OSF, and WDFW is actively pursuing a conservation easement for this property. This site borders the Newman Property which has the largest OSF breeding population in the Allen's Creek drainage (**Figure 25 – North**). The targeted area for conservation contains 100m of Allen's Creek along the south boundary and 165m of Blooms Ditch, a tributary of Allen's Creek, along the northern boundary for a total of 260m of creek within the management area (**Figure 26**). The site also contains 23 acres of wetlands, all of which are either permanently or seasonally flooded.

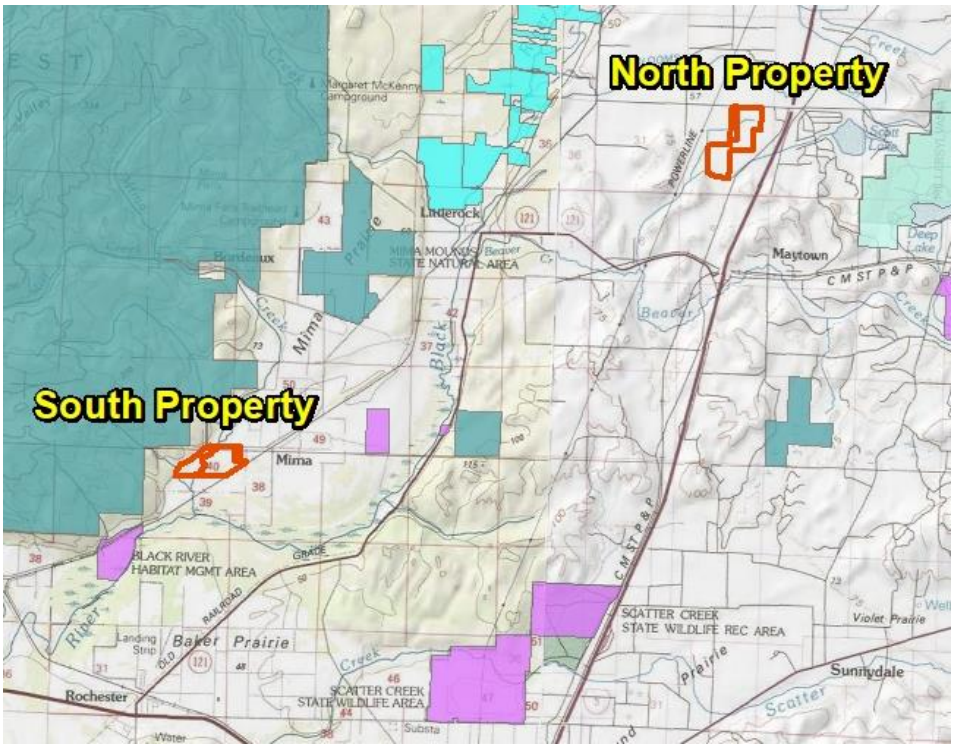

Figure 25. *Conservation area of Ames & Rogers Property*

***Figure 2**. Conservation area of Rogers Property in white. Orange is full parcel boundary.*

- *Habitat enhancement/maintenance of breeding/rearing locations and egg mass monitoring* - WDFW

RCG invasion threatens all wet portions of the property. Currently grazing and haying of RCG exists under the guidance of the USDA NRCS "Grazing/forage harvest guidelines for maintaining breeding habitat for Oregon spotted frog". This keeps the habitat suitable for OSF and provides economic benefit to the landowner. Spraying for invasive species like Himalayan Blackberry and Scotch Broom occurred in 2020 (~0.5 acres) and we anticipate follow up in 2021 with spot spraying areas of regrowth (**Figure 27**).

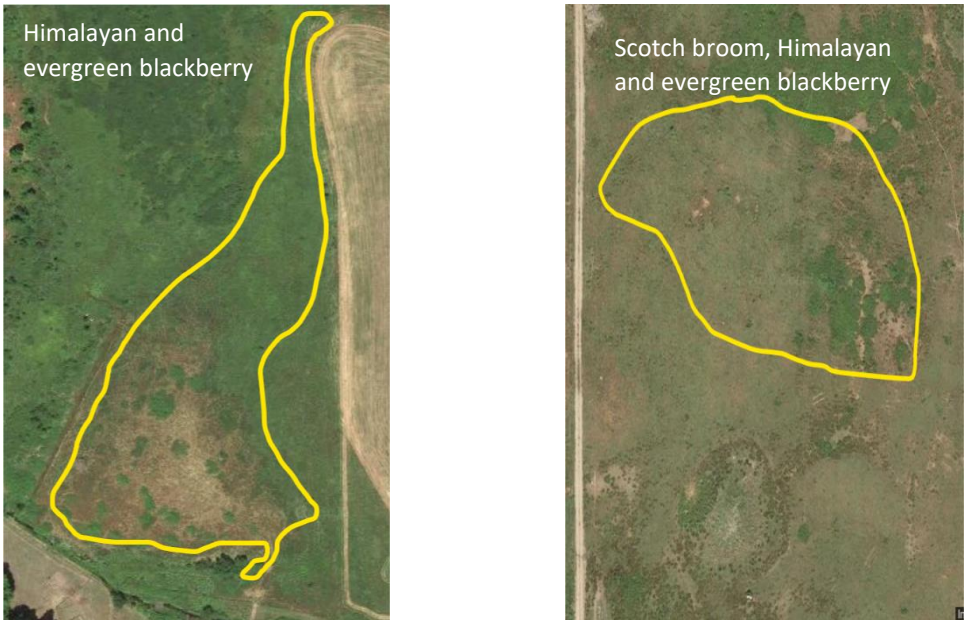

***Figure 27.** Location of invasive species spraying for Rogers Property including Blackberries and Scotch Broom*

Ames Property Restoration - WDFW Regional Biologists

This location borders the Mima Creek OSF spotted frog oviposition site owned by Centers for Natural Lands Management (CNLM) and shares hydrology with Mima Creek (**Figure 25 – South & Figure 28**). After CNLM started enhancement activities on their property in 2014 (including mowing of RCG and pond creation), OSF oviposition was documented.

WDFW acquired the Ames property in 2021 and has proceeded forward with goals of enhancement of RCG areas and wetland creation in a seasonally flooded field to provide OSF oviposition habitat similar to the adjoining Mima Creek property. This project would be conducted in three phases with Phase 1 funded this past biennium: 1) permitting/preparation to include JARPA, HPA, biologic opinion, construction blueprints, 2) site prep/construction of the pond(s), and 3) plantings/post construction work.

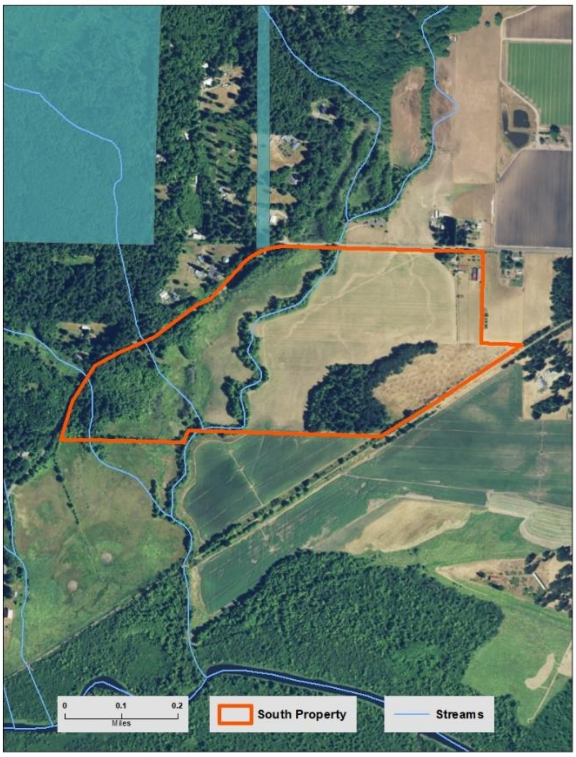

***Figure 28**. Ames Property*

Phase 1 water loggers were installed in March 2021 to determine the hydrology patterns of the site and to inform the placement of the proposed created ponds (Phase 2). Pat Klavas, DFW CAMPS hydrologist downloaded the loggers at the property on April 27 and indicated that, although the water levels on the site had dropped approximately 0.3" since March installation, there were still pockets of deep water (although becoming disconnected from one another), there was still water in all the stand pipes, and one gauge had spiked to about 0.4" after a heavy rain event on April 24th. These preliminary results indicate that the site responds quickly to rainfall which should benefit WDFW's goals of creating and maintaining ponds for OSF habitat.

Ongoing Work and Next Steps: In the upcoming 21-23 biennium we are continuing habitat enhancement and restoration activities as described in this document as well OSF monitoring efforts. This work

contributes to our ongoing Status & Trends monitoring as part of the ASRP and will guide future research and management needs contingent on the outcomes of this ongoing work.

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